8th International Conference on Physical and Numerical Simulation of Materials Processing (ICPNS)

14–17 October 2016

Seattle, Washington | Hosted by Purdue University

SESSION 5: IRON AND STEEL, HARBOR HALL

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SATURDAY, OCTOBER 15, 2016

Numerical simulation of residual stress in low-temperature colossal carburized layer on austenitic stainless steel

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ABSTRACT

A numerical model is proposed to quantitatively characterize the residual stress evolutions in low-temperature colossal carburized layer on austenitic stainless steel. In this model, on the basis of the consideration of concentration and stress-dependent carbon diffusivity, prediction of the carbon concentration distribution and growth regularity of carburized layer is performed. The strain rate is discussed taking the composite effects of residual stress, carbon concentration gradient, and thermal expansion. Based on the strain compatibility of carburized layer and substrate, the residual stress is calculated. Meanwhile, a low-temperature colossal carburization experiment is carried out on 316L austenitic stainless steel, and the carbon concentration and residual stress are measured to verify the validity of the model. The numerical results of carbon concentration and residual stress distributions agree with the experimental data, indicating that the numerical model established in this paper can be used to investigate the process of low-temperature colossal carburization.

KEYWORDS: low-temperature colossal carburization, residual stress, numerical model, austenitic stainless steel, carbon diffusivity